Stability limit of a metastable state of hcp solid helium-4

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Solid helium has the unique feature of having an horizontal melting curve in the P,T plane. This offers novel opportunities to study the stability limits of a metastable solid, by using the pressure as a control parameter of the metastability. We produce a metastable sample by focusing inside the crystal a 1 MHz ultrasonic sound pulse that matches the anisotropic compressional wavesurface of solid helium-4. The density of the metastable state is addressed by using an interferometric imaging technique. We found that 4 bar below the melting pressure, the metastable crystal seems to reach its stability limit. This instability occurs at much higher pressure than those predicted by nucleation theory or Monte-Carlo simulations. Repeated experiments show that the instability initially appears during negative pressure swings, as a small defect ($\sim$ 0.2 mm) located at the maximum isotropic strain. Further studies are performed to understand the underlying mechanism of the instability. Possible scenarios accounting for this unexpected observation are discussed.

Section: QS - Quantum solids

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